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(71) Applicant: KONINKLIJKE PHILIPS ELECTRONICS N.V. [NL/NL]; Groenewoudseweg 1, NL-5621 BA Eindhoven (NL).

(72) Inventor: BREKELMANS, Johannes, H.; Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL).

(74) Agent: STEENBEEK, Leonardus, J.; Internationaal Octrooibureau B.V., Prof Holstlaan 6, NL-5656 AA Eindhoven (NL).

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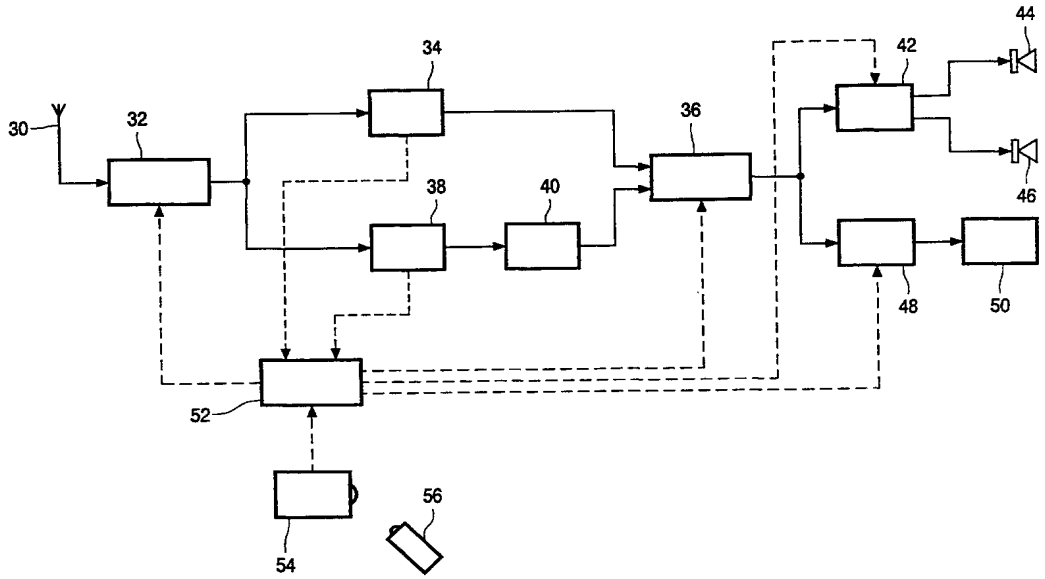
(54) Title: SPEEDING UP SEARCH TUNING IN TELEVISION RECEIVERS



(57) Abstract: A method of performing a search tuning of television signals in a television band containing both analog and digital television signals. First, an analog channel search is performed to determined all of the analog channels receivable in the television band. Then, a digital channel search is performed in which the analog channels determined in the analog channel search are skipped. Since a digital channel search necessarily uses significantly smaller frequency steps than in the analog channel search, a considerable amount of time is saved by not searching the already determined analog channels.

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Speeding up search tuning in television receivers

BACKGROUND OF THE INVENTION

Field of the invention

The subject invention relates to the tuning of a television receiver connected to a cable subscriber network, and, in particular, to a tuning procedure known as "search tuning".

Description of the related art

With very few exceptions, television receivers for existing analog television signals are able to automatically scan the source signals in the frequency domain for usable channels which are then stored in memory for later recall. Although various frequency allocation plans exist for cable networks, the practical situation is that the amount of exceptions and deviations call for a search algorithm that can find channels at any frequency within the band. Search through all of the television receiving band needs to be accomplished within a reasonable amount of time (typically within 1 minute) to avoid customer annoyance. Fast tuning is realized by scanning the band taking relatively large frequency steps at a time. This is possible in that the demodulator used for traditional analog television systems has a relatively large latitude against mis-tuning of, for example, 1000 kHz. Even though tuning is not accurate, the demodulator is able to lock onto the signal and to provide feedback about the frequency error to the host micro-controller which is then able to refine the tuning of the tuner to the exact frequency.

DE 197 28 765 A1 discloses a method for automatic channel storage and selection for television channels with cable television signals by sequentially outputting tuning data and storing channels with signal for wireless television by outputting the tuning data when a signal from the automatic channel setting is inputted.

A typical search tuning system operates as follows. The system determines first whether the last channel is done. If so, the system exits the procedure. If not, the system selects the next channel number. The channel number is stored in the television receiver along with the nominal frequency of the channel. As shown in Fig. 1A, each channel has a bandwidth of, for example, 6 MHz. In order to search for the received television signal, the

system scans the bandwidth of the channel in, for example, 1000 kHz sub-band frequency steps starting at a first channel sub-band frequency step which is the lowest frequency within the channel bandwidth around the nominal frequency of the particular channel. Then, the system attempts to acquire the next television signal. Subsequently, the system determines whether the next television signal has been acquired. If so, the system then stores the channel-frequency data. After the storage of the channel-frequency data, the system goes back to the first step to determine if this channel is the last channel number. If, the television signal has not been acquired, the system determines if this is the last channel sub-band frequency step in the bandwidth of the particular channel. If not, the system selects a next channel sub-band frequency step and then goes back to the acquire next television signal step to attempt to acquire the television signal. If this is the last channel sub-band frequency step in the bandwidth of the particular channel, the system goes back to the first step where it is determined whether this is the last channel number.

With the introduction of several new digital television transmission signals, both on cable and over-the-air broadcasts, the demand has arisen for television receivers capable of receiving both analog and digital television signals. The signal applied to such a television receiver can now comprise a mix of traditional analog RF signals as well as digital television (DTV) RF signals, which may be 64/256 QAM, 8/16 VSB. However, demodulators for DTV signals require that the oscillator frequency of the demodulator be within, for example, 50-150 kHz of the received DTV signal in order for the demodulator to lock onto the received DTV signal and to provide feedback information about the actual carrier frequency. This requires the search tuning to scan the bands with considerably smaller steps than those used when scanning the analog television channels (e.g., 125 kHz, see Fig. 1B) and, hence, considerably increases the search tuning time.

SUMMARY OF THE INVENTION

It is an object of the present invention to minimize the amount of time needed to search tune for all available television signals in a network carrying a mix of both analog and digital television signals.

To this end, the invention provides a search tuning as defined by the independent claims. The dependent claims define advantageous embodiments.

Since the DTV signals are not broadcast on the same channels/frequency as the analog television signals, it is not necessary for the television receiver to search the entire television frequency band to determine the available DTV signals. By first performing an analog television signal search, which may be done relatively rapidly, the television receiver

may then eliminate the channel-frequency positions of the determined analog television signals. The television receiver then need only search/scan at the channel-frequency positions unoccupied by analog television signals.

BRIEF DESCRIPTION OF THE DRAWINGS

With the above and additional objects and advantages in mind as will hereinafter appear, the invention will be described with reference to the accompanying drawings, in which:

Fig. 1A is a diagram of a television channel showing an analog channel sub-band frequency step of 1000 kHz, and Fig. 1B is a diagram of a television channel showing a digital channel sub-band frequency step of 125 kHz; and

Fig. 2 is a schematic block diagram of a television receiver capable of receiving both analog and digital television signals;

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Fig. 2 shows a schematic block diagram of a television receiver capable of receiving both analog and digital television signals. The television signals are applied to the television receiver via and antenna 30. While antenna 30 is shown, it should be understood that the television signals may alternatively be provided by a CATV system or by a combination of a standard television antenna and a satellite antenna, etc. The antenna 30 is connected to a tuner 32 for tuning to the various television signals. An analog demodulator 34 is connected to the output of the tuner 32 and applies an output to one input of a switch 36. A digital demodulator 38 is also connected to the output of the tuner 32 includes a phase-locked loop having a tuning resolution of, for example, 62.5 kHz. After being converted in a D/A converter 40, the output of the digital demodulator 38 is applied to a second input of the switch 36. The output from the switch 36 is applied to an audio signal processor 42 for generating audio signals for loudspeakers 44 and 46. In addition, the output from the switch 36 is also applied to a video signal processor 48 for generating video signals for a display 50.

The tuning of the tuner 32 is controlled by a micro-controller 52 which receives error signals from the analog and digital demodulators 34 and 38. Depending upon whether and analog or digital television signal is being tuned, the micro-controller 52 controls the switching position of switch 36. In addition, the micro-controller 52 applies control signals to the audio signal processor 42 for controlling audio parameters of the

reproduced audio signal, and to the video signal processor 48 for controlling visual parameters of the reproduced video signal. The micro-controller 52 is controlled by a user using user controls 54 or, alternatively, a remote control transmitter 56 sending infra-red signals to a infra-red receiver on the user controls 54.

A listing of all television channels as well as their respective nominal carrier frequencies is stored in the micro-controller 52. While various allocation plans exist, in actuality, the actual carrier frequency of a television signal for a particular channel can vary anywhere within the channel bandwidth around the nominal carrier frequency. Therefore, it is necessary that the micro-controller 52 perform a search tuning to find the actual carrier frequencies of all available television channels.

The procedure by which the above television receiver search tunes both analog and digital television signals, can be described as follows. Upon starting the procedure, the television receiver performs an analog channel search. This search may be the same as that shown in Fig. 1. While, as noted above, the frequency step-size for the analog channel search has been set at 1000 kHz, it should be understood that this step-size is arbitrary and may be set at other values, for example, in the range 750-1250 kHz. Following the analog channel search, the television receiver then performs a digital channel search, after which the procedure is stopped.

The procedure, by which the television receiver performs a digital channel search, can be described as follows. After performing the analog channel search, the procedure, determines whether the current channel is the last channel in the television band. If so, the procedure stops. If not, the television receiver goes to the next channel number and compares this channel number to those of the television signals acquired in the analog channel search. If, the current channel number corresponds to a stored analog channel number, the procedure goes back to the first step. If not, the procedure sets the first channel sub-band frequency step for the current channel. Then, the television receiver attempts to acquire the digital signal. If the digital signal is acquired, the television receiver stores the digital channel-frequency data, and then goes back to the first step. If not, the procedure determines whether the current channel sub-band frequency step is the last in the current channel. If not, the procedure goes to the next channel sub-band frequency step, and the procedure goes back to the digital signal acquiring step. If the current channel sub-band frequency is the last in the current channel, the procedure goes back to the first step.

As noted above, the digital demodulator 38 has a tuning resolution of 62.5 kHz. Therefore, in order to ensure that the proper carrier frequency is found, the step-size of the channel sub-band frequency is set at 2 times the tuning resolution, i.e., 125 kHz.

In summary, by first performing the faster analog channel search, when the digital channel search is performed, the assigned analog channels can be eliminated from the digital channel search thus significantly reducing the time involved by the digital channel search to scan and search the television band.

It should be noted that the above-mentioned embodiments illustrate rather than limit the invention, and that those skilled in the art will be able to design many alternative embodiments without departing from the scope of the appended claims. In the claims, any reference signs placed between parentheses shall not be construed as limiting the claim. The word "comprising" does not exclude the presence of elements or steps other than those listed in a claim. The word "a" or "an" preceding an element does not exclude the presence of a plurality of such elements. The invention can be implemented by means of hardware comprising several distinct elements, and by means of a suitably programmed computer. In the device claim enumerating several means, several of these means can be embodied by one and the same item of hardware. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage.

CLAIMS:

1. A method for search tuning

in television receivers for both analog and digital signals, said method comprising the steps:

receiving an input television signal including a plurality of analog and digital television signals;

acquiring all of said analog television signals in said input television signal and the assigned channel numbers of said acquired analog television signals; and

acquiring all of said digital television signals in said input television signal and the assigning channel numbers of said acquired digital television signals, wherein said step of acquiring said digital television signals includes the step:

skipping the channel-frequency positions of the acquired analog television signals, as determined in said step of acquiring said analog television signals.

2. The method as claimed in claim 1, wherein said step of acquiring said analog television signals comprises the steps:

determining whether a current channel number is the last channel number, and if so terminating the routine;

selecting a next channel number;

selecting a first channel sub-band frequency step;

attempting to acquire a television signal within said channel sub-band frequency;

storing channel-frequency data if a television signal is acquired, and going back to said step of determining whether a current channel number is the last channel number;

if a television signal is not acquired, determining whether said current channel sub-band frequency step is the last channel sub-band frequency step within the bandwidth of the current channel, and if so going back to the step of determining whether the current channel number is the last channel number; and

if the current channel sub-band frequency step is not the last channel sub-band frequency step, selecting the next channel sub-band frequency step and then going back to the step of attempting to acquire a television signal.

3. The method as claimed in claim 2, wherein said channel sub-band frequency step is in the frequency range of 750-1250 kHz.

4. The method as claimed in claim 3, wherein said channel sub-band frequency step is 1000 kHz.

5. The method as claimed in claim 1, wherein said step of acquiring said digital television signals comprises the steps:

determining whether a current channel number is the last channel number, and if so terminating the routine;

selecting a next channel number;

comparing the current channel number with the stored analog channel number;

if the comparing step results a match, going back to said determining step;

selecting a first digital channel sub-band frequency;

attempting to acquire a television signal within said digital channel sub-band frequency;

storing channel-frequency data if a television signal is acquired, and going back to said step of determining whether a current channel number is the last channel number;

if a television signal is not acquired, determining whether said current digital channel sub-band frequency is the last digital channel sub-band frequency within the bandwidth of the current channel, and if so going back to the step of determining whether the current channel number is the last channel number; and

if the current digital channel sub-band frequency is not the last channel sub-band frequency, selecting the next digital channel sub-band frequency and then going back to the step of attempting to acquire a television signal.

6. The method as claimed in claim 5, wherein a step-size of said digital channel sub-band frequency is two times the tuning resolution of a digital demodulator in the television receiver.

7. The method as claimed in claim 6, wherein said step-size is 125 kHz.

8. The method as claimed in claim 2, wherein said digital channel search comprises the steps:

determining whether a current channel number is the last channel number, and if so terminating the routine;

selecting a next channel number;

comparing the current channel number with the stored analog channel number;

if the comparing step results a match, going back to said determining step;

selecting a first digital channel sub-band frequency;

attempting to acquire a television signal within said digital channel sub-band frequency;

storing channel-frequency data if a television signal is acquired, and going back to said step of determining whether a current channel number is the last channel number;

if a television signal is not acquired, determining whether said current digital channel sub-band frequency is the last digital channel sub-band frequency within the bandwidth of the current channel, and if so going back to the step of determining whether the current channel number is the last channel number; and

if the current digital channel sub-band frequency is not the last channel sub-band frequency, selecting the next digital channel sub-band frequency and then going back to the step of attempting to acquire a television signal.

9. A device for search tuning in television receivers for both analog and digital signals, said device comprising:

means for receiving an input television signal including a plurality of analog and digital television signals;

means for acquiring all of said analog television signals in said input television signal and the assigned channel numbers of said acquired analog television signals; and

means for acquiring all said digital television signals in said input television signal and the assigning channel numbers of said acquired digital television signals, wherein said means for

acquiring said digital television signals include:

means for skipping channel-frequency positions of the acquired analog television signals, as determined by said

means for acquiring said analog television signals.

10. A television receiver, comprising;

a search tuning device as claimed in claim 9;

a video signal processor coupled to said search tuning device; and

a display coupled to said video signal processor.

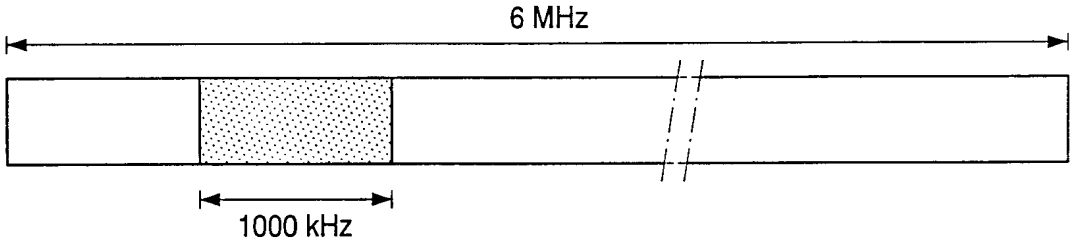

FIG. 1A

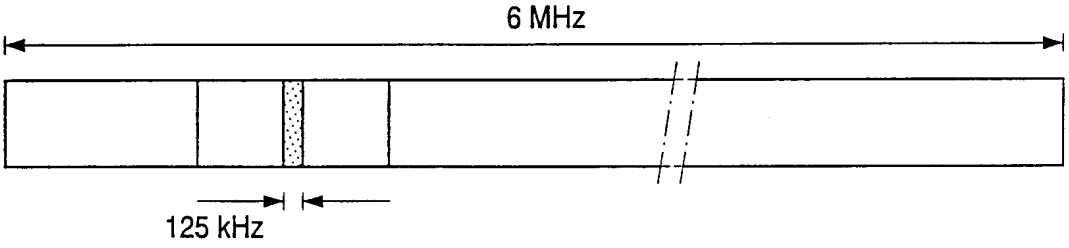

FIG. 1B

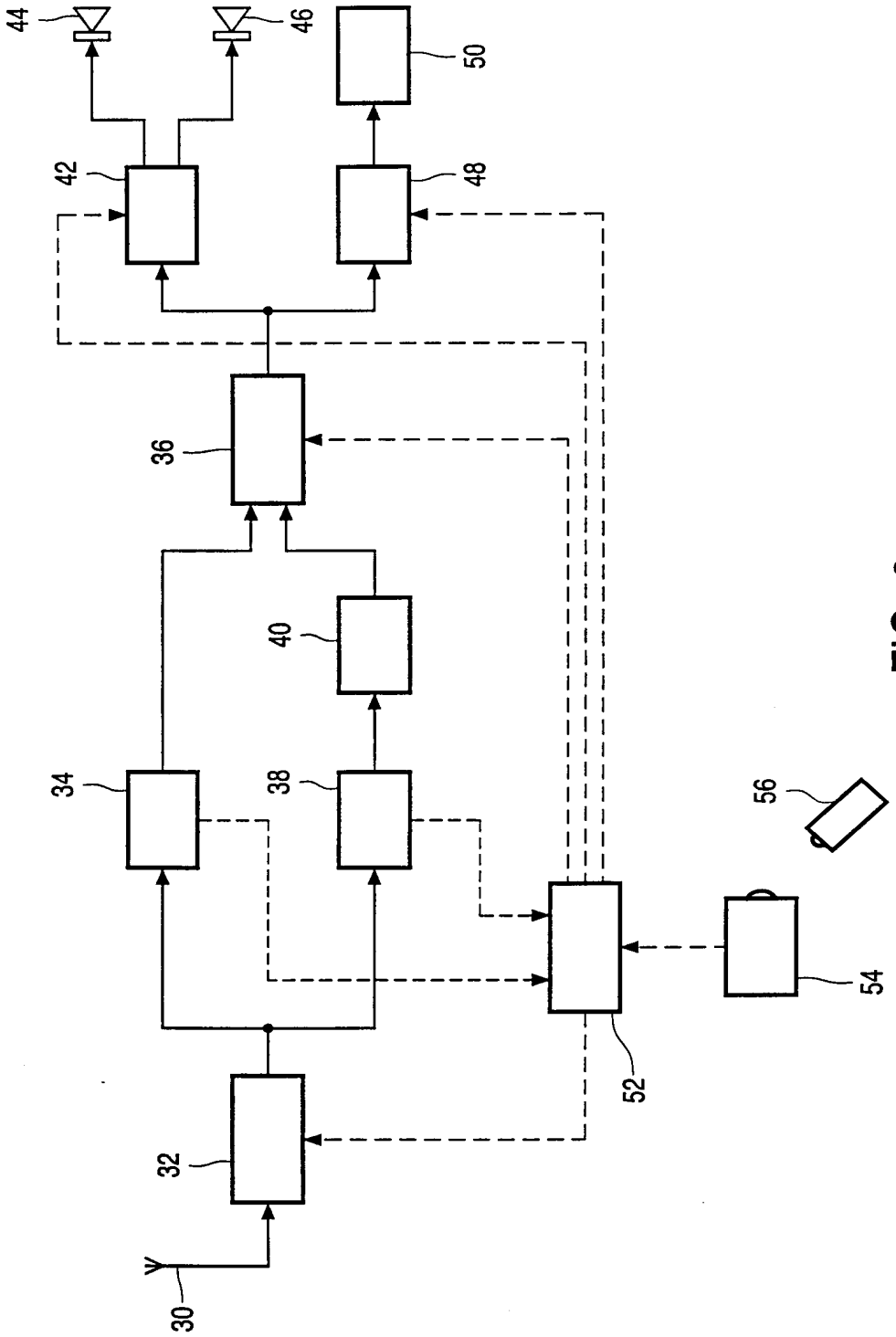

FIG. 2

INTERNATIONAL SEARCH REPORT

Inte onal Application No
PCT/EP 00/12261

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H03J1/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H03J H04N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 774 194 A (ARMBRUSTER VEIT) 30 June 1998 (1998-06-30) abstract	1,9
A,P	EP 0 978 940 A (PIONEER CORP) 9 February 2000 (2000-02-09) abstract; figure 1	1,9
A	DE 197 28 765 A (LG ELECTRONICS INC) 22 January 1998 (1998-01-22) cited in the application the whole document	1,9

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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Date of the actual completion of the international search	Date of mailing of the international search report
26 March 2001	30/03/2001

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Peeters, M

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INTERNATIONAL SEARCH REPORT

Information on patent family members

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